The Ecosystem Functions Model

A Tool for Restoration Planning

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What is the EFM?

- A planning tool used by biologists, geomorphologists, engineers, scientists…that analyzes eco-response to changes in the flow regime (e.g., reservoir operations or channel modifications)
- Indicates direction and relative magnitude of change
- Use hydrologic and hydraulic data to help predict biological response

The EFM has been developed by USACE and the Reclamation Board of California, with assistance from California Department of Water Resources, Jones and Stokes, and Ford Consultants.

Efforts have been supported primarily by the Sacramento and San Joaquin Basins Comprehensive Study.

Input and Data Requirements
(What Do You Need?)

Statistical Assessment Only…

- Hydrologic Data (period of record)
  - Flow and stage time series
- Relationships between hydrology and ecology

…and for Spatial Features

- Topographic Data (DTM)
- Geo-referenced Hydraulic Model
- GIS Software and Data

Relationships
(To be used as indicators of eco-change)

- Relationships link characteristics of hydrologic and hydraulic time series (flow and stage) to elements of the ecosystem through combinations of four basic criteria:

1. Season
2. Flow frequency
3. Duration
4. Rate of Change

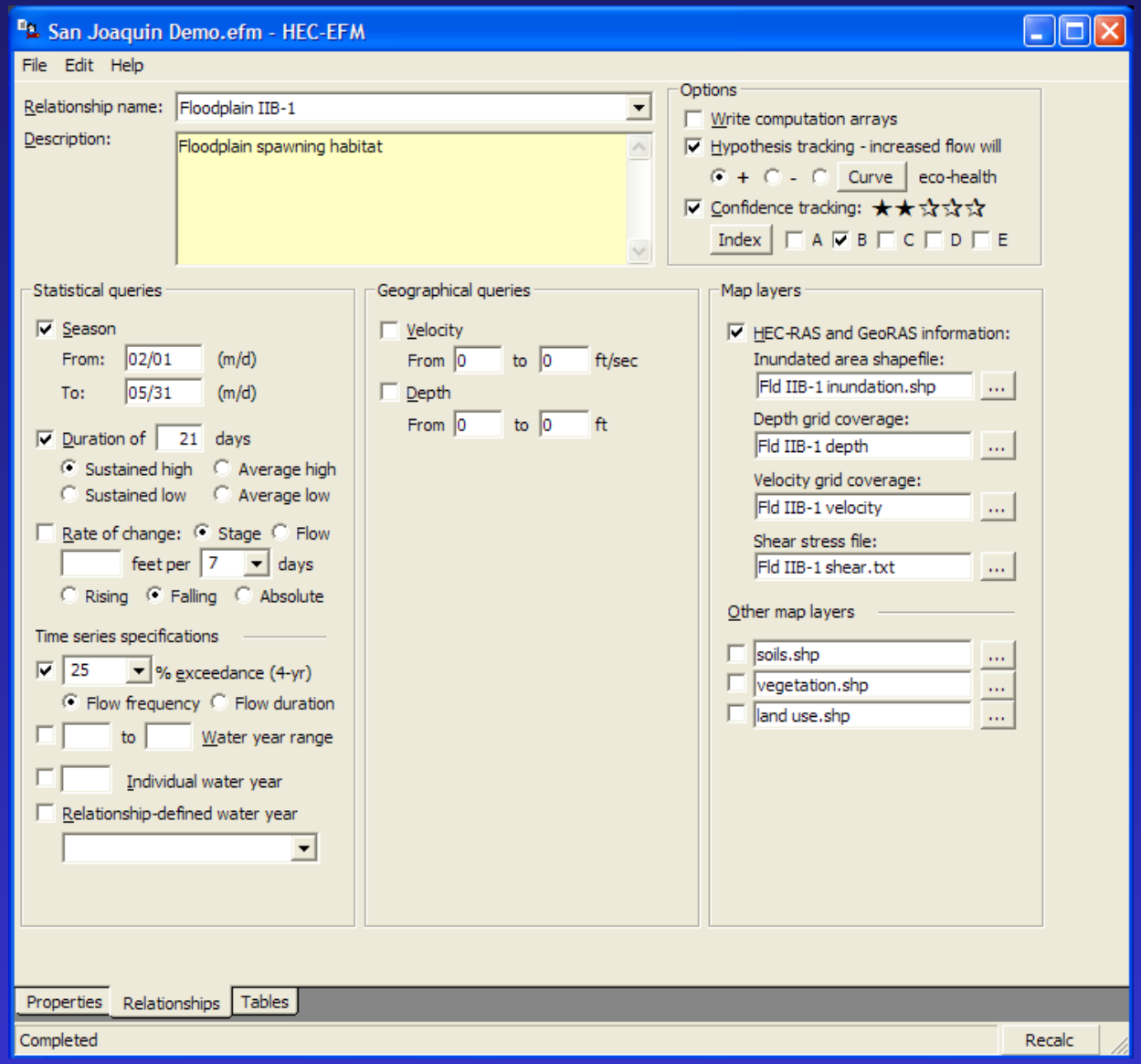
- Statistical analyses performed on the time series records to determine the flow and stage that meet the criteria for each relationship.

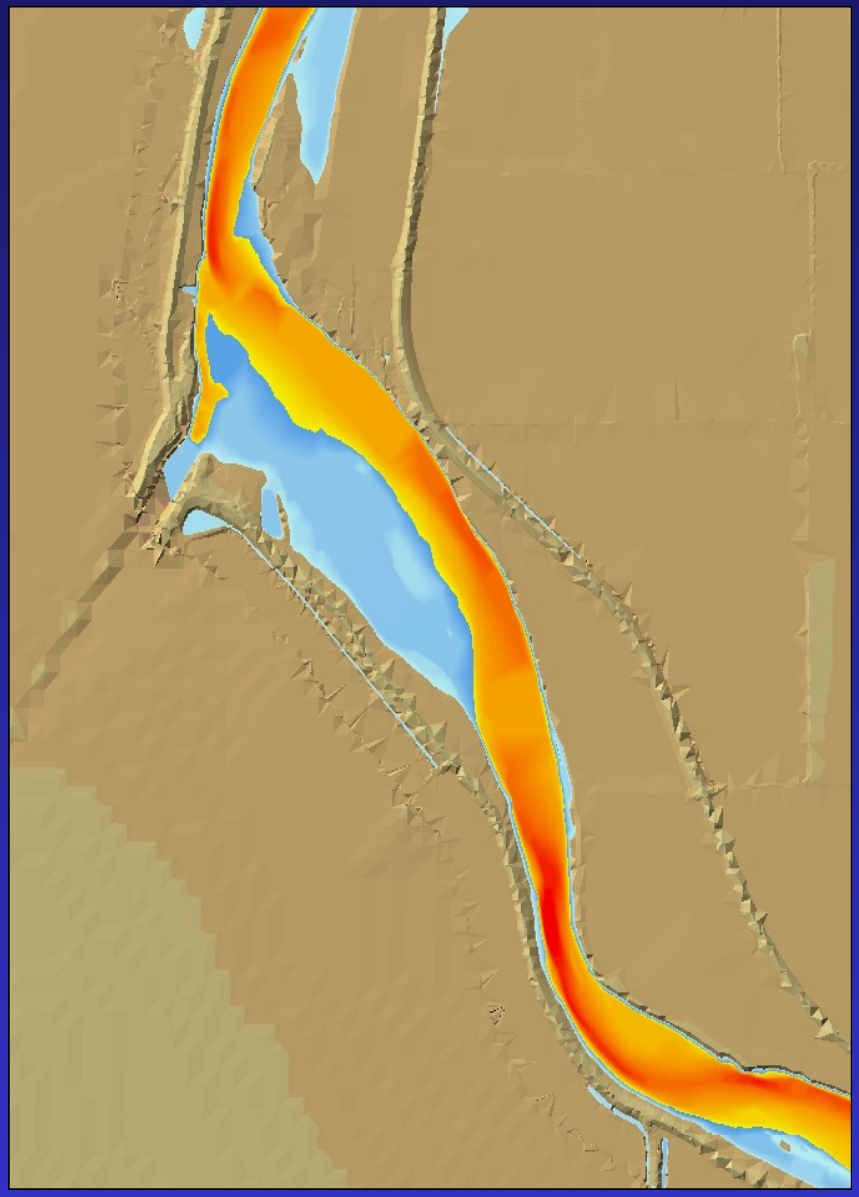
The initial application of the ELFM used fifteen relationships to investigate a range of ecosystem elements, including fish spawning, fish rearing, fish stranding, recruitment of large woody debris, channel migration, riparian forest regeneration, and many others.

Sample Aquatic Relationship
(Floodplain Spawning Habitat)

- Physical Parameter: Overbank flows that exceed threshold duration
- Ecological Response: Suitable floodplain fish-spawning habitat
- Relationship: 1) Occur Feb thru May; 2) Duration of 21 days; 3) Return period < 4 years
- Output: GIS Layer of areas suitable for floodplain spawning

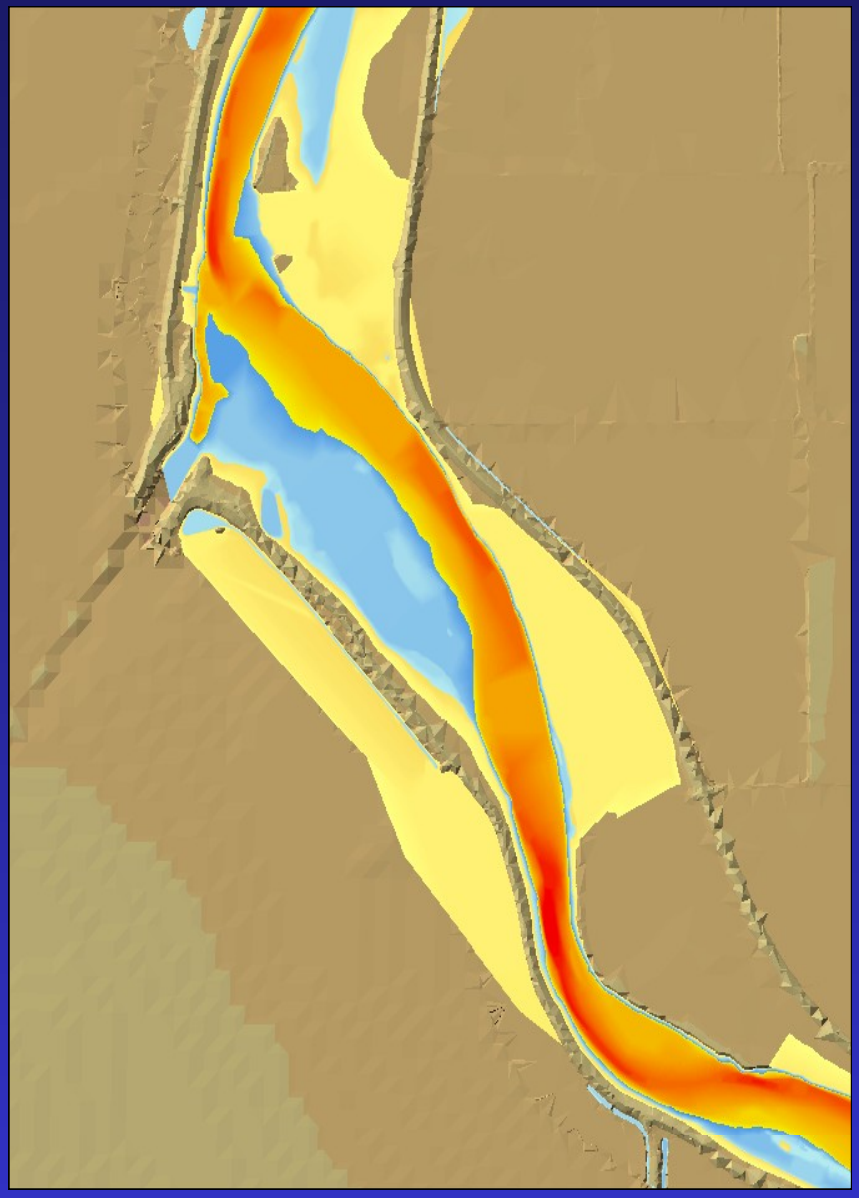
Floodplain Spawning Relationship





Floodplain Spawning Habitat - Without Project

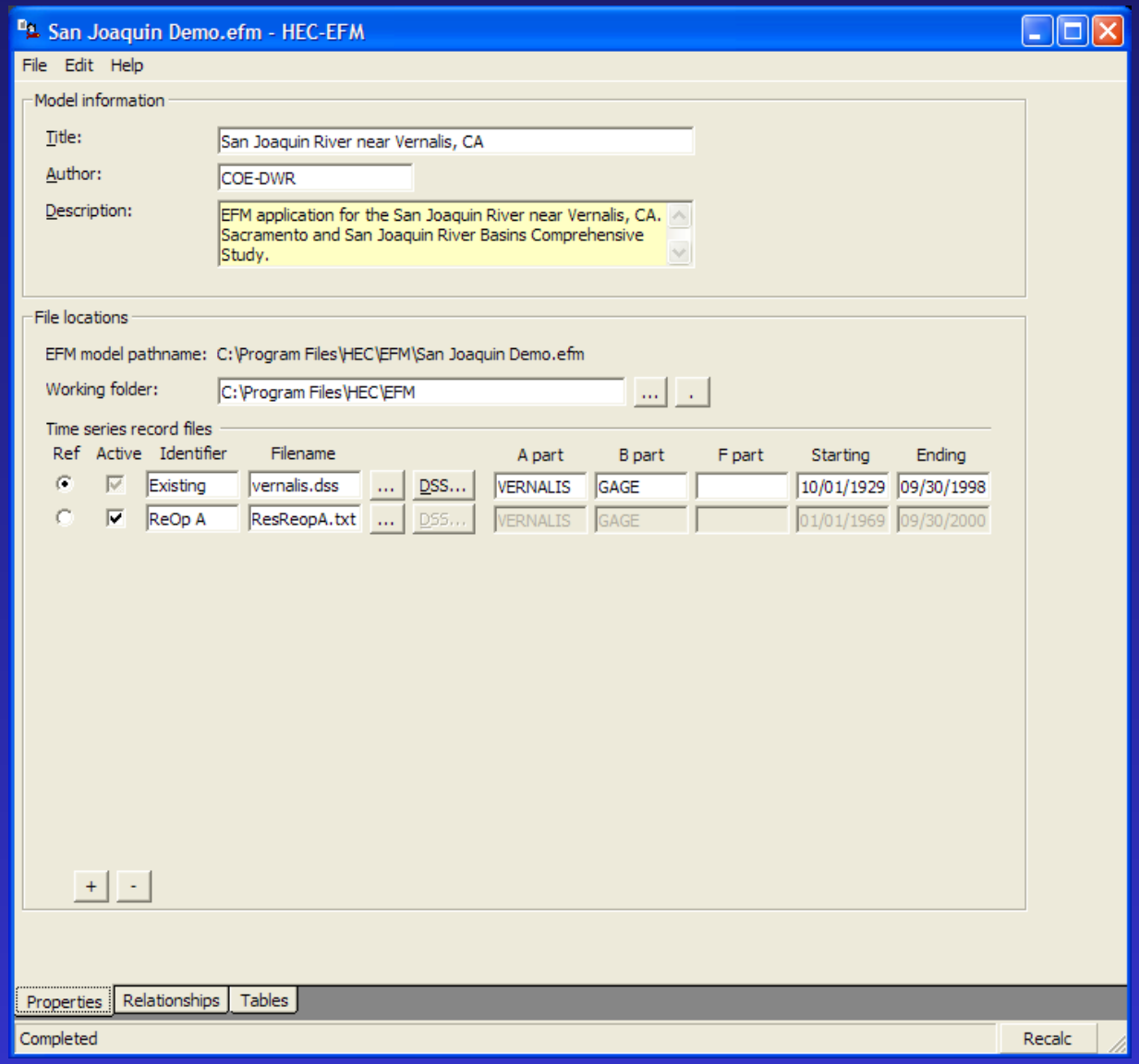
- Floodplain Spawning
  - Flow is 17,550-cfs
  - Stage is 17.2-ft
- Channel Habitat designated as 1.5-yr inundation



Floodplain Spawning Habitat - With Project

- With Project
  - Increased flow and stage
- Without Project
  - Flow is 17,550-cfs
  - Stage is 17.2-ft

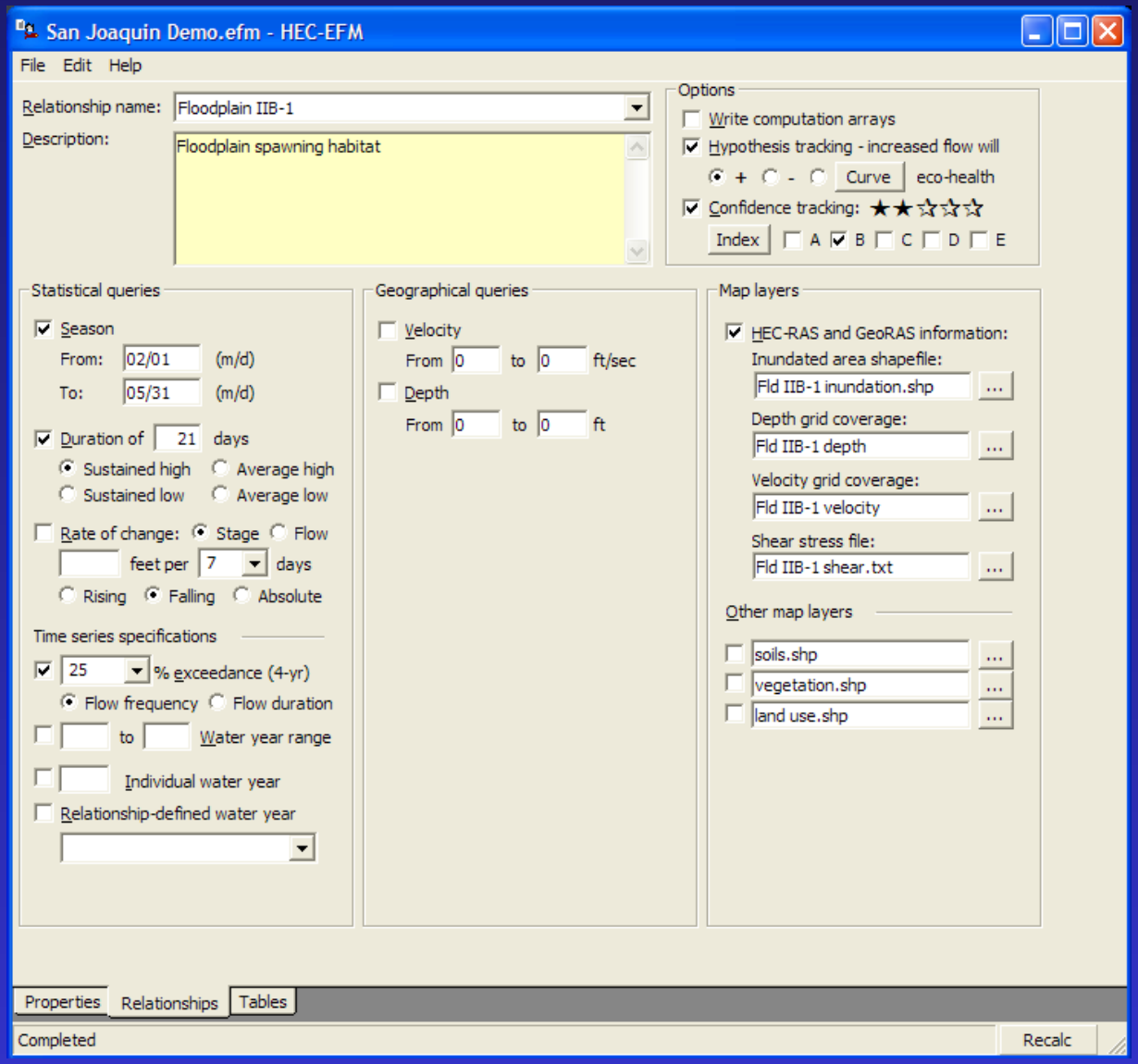
EFM Interface - Properties Tab


San Joaquin Demo.efm - HEC-EFM
File Edit Help
Model information
Title: San Joaquin River near Vernalis, CA
Author: COE-DWR
Description: EFM application for the San Joaquin River near Vernalis, CA. Sacramento and San Joaquin River Basins Comprehensive Study.
File locations
EFM model pathname: C:\Program Files\HEC\EFM\San Joaquin Demo.efm
Working folder: C:\Program Files\HEC\EFM
Time series record files
Ref Active Identifier Filename A part B part F part Starting Ending
Existing vernalis.dss DSS... VERNALIS GAGE 10/01/1929 09/30/1998
ReOp A ResReopA.txt DSS... VERNALIS GAGE 01/01/1969 09/30/2000
Properties Relationships Tables
Completed
Recalc

New Stuff:

- Multiple Input Files
- Reference Series
- DSS Compatible
- Comma, Tab, Space delimited input
- Flexible Start and End Dates

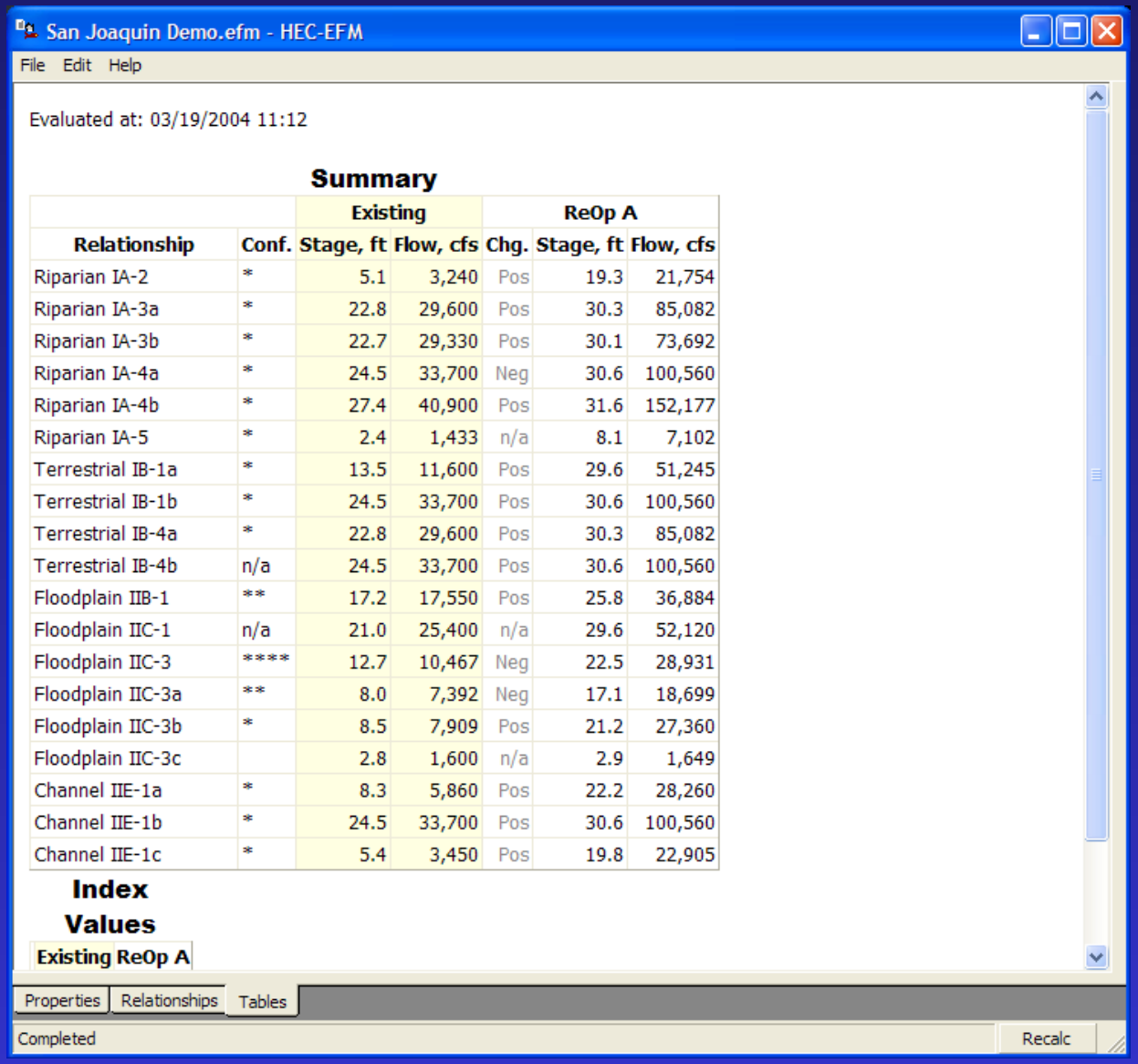
EFM Interface - Relationships Tab



New Stuff:

- Output Arrays
- Hypothesis Tracking
- Confidence Tracking
- Indices
- Statistical Options
- Time Series Options

EFM Interface - Statistical Results

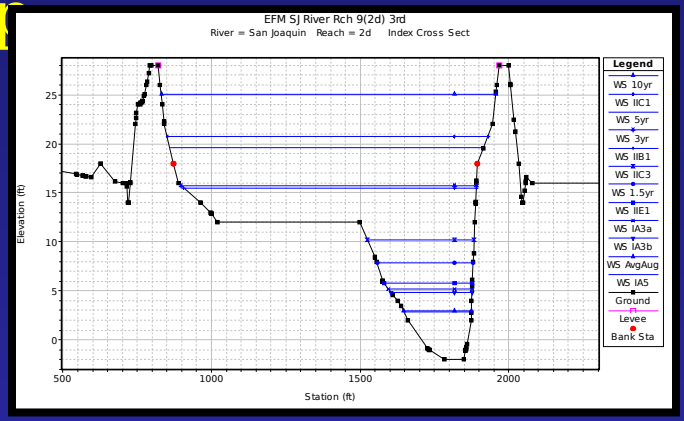

San Joaquin Demo.efm - HEC-EFM
File Edit Help
Evaluated at: 03/19/2004 11:12
Summary
Existing
ReOp A
Relationship | Conf. | Stage, ft | Flow, cfs | Chg. | Stage, ft | Flow, cfs
Riparian IA-2 | * | 5.1 | 3,240 | Pos | 19.3 | 21,754
Riparian IA-3a | * | 22.8 | 29,600 | Pos | 30.3 | 85,082
Riparian IA-3b | * | 22.7 | 29,330 | Pos | 30.1 | 73,692
Riparian IA-4a | * | 24.5 | 33,700 | Neg | 30.6 | 100,560
Riparian IA-4b | * | 27.4 | 40,900 | Pos | 31.6 | 152,177
Riparian IA-5 | * | 2.4 | 1,433 | n/a | 8.1 | 7,102
Terrestrial IB-1a | * | 13.5 | 11,600 | Pos | 29.6 | 51,245
Terrestrial IB-1b | * | 24.5 | 33,700 | Pos | 30.6 | 100,560
Terrestrial IB-4a | * | 22.8 | 29,600 | Pos | 30.3 | 85,082
Terrestrial IB-4b | n/a | 24.5 | 33,700 | Pos | 30.6 | 100,560
Floodplain IIB-1 | ** | 17.2 | 17,550 | Pos | 25.8 | 36,884
Floodplain IIC-1 | n/a | 21.0 | 25,400 | n/a | 29.6 | 52,120
Floodplain IIC-3 | **** | 12.7 | 10,467 | Neg | 22.5 | 28,931
Floodplain IIC-3a | ** | 8.0 | 7,392 | Neg | 17.1 | 18,699
Floodplain IIC-3b | * | 8.5 | 7,909 | Pos | 21.2 | 27,360
Floodplain IIC-3c | | 2.8 | 1,600 | n/a | 2.9 | 1,649
Channel IIE-1a | * | 8.3 | 5,860 | Pos | 22.2 | 28,260
Channel IIE-1b | * | 24.5 | 33,700 | Pos | 30.6 | 100,560
Channel IIE-1c | * | 5.4 | 3,450 | Pos | 19.8 | 22,905
Index Values
Existing ReOp A
Properties Relationships Tables
Completed
Recalc

New Stuff:

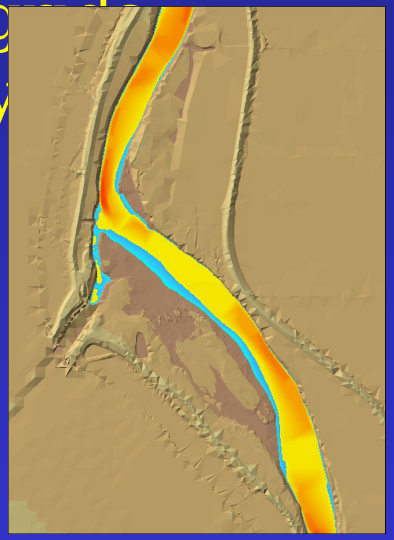
- Multiple Time Series Output
- Confidence and Hypothesis Output
- Index Values

Going Spatial…

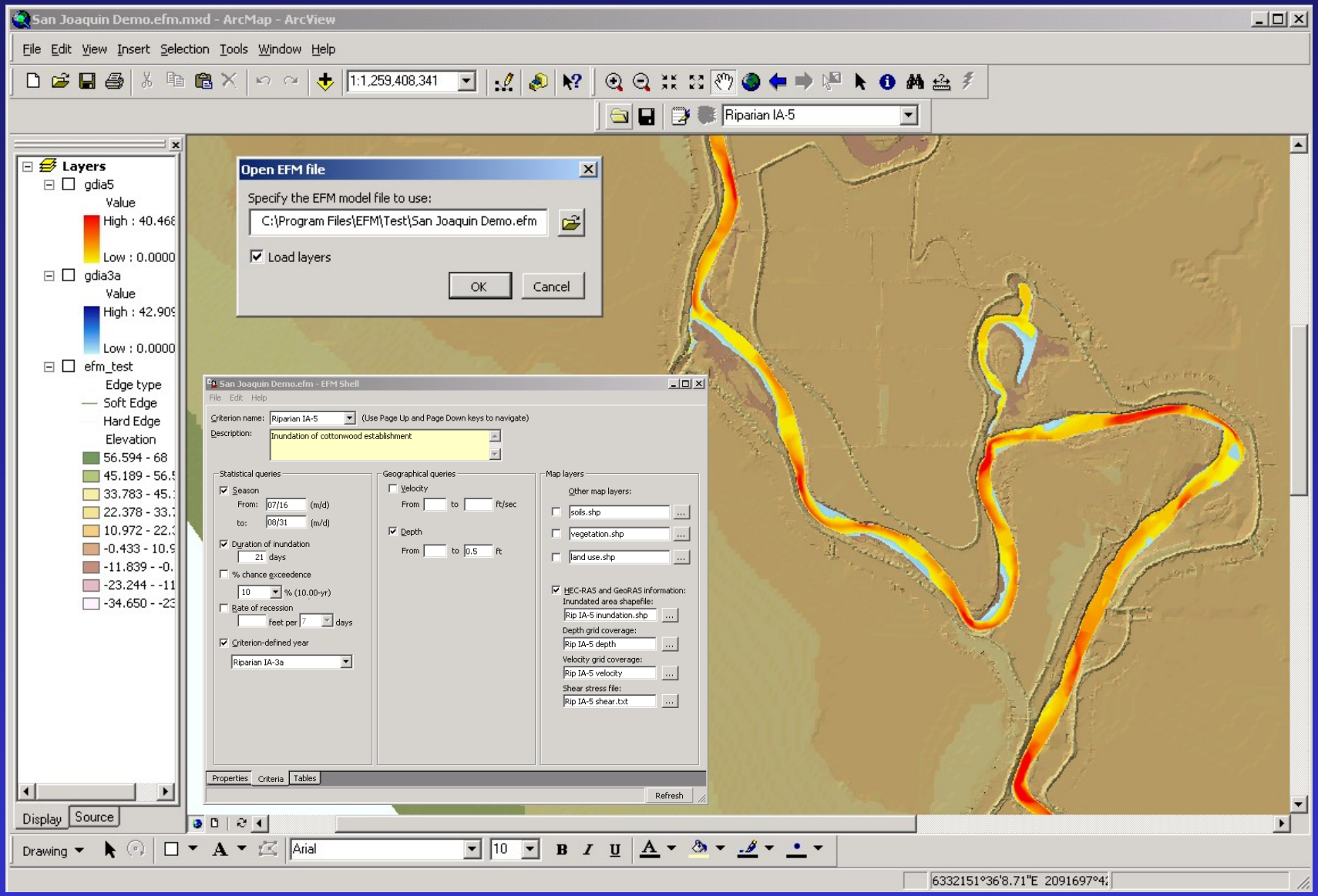
- Statistical results (flows) are input to a hydraulic model (HEC-RAS) to develop
  - Water surface profiles
  - Shear stress



- GeoRAS distributes RAS output into g
  for GIS analysis and display
  - Depth grid
  - Velocity grid
  - Inundation boundary maps



EFM – Spatial Processor



Present and Near-Future EFM

Software:

- Interface for stats package
- ArcGIS accessory for spatial processing
- GIS operations packaged
- File and project management

Applications:

- Sacramento and San Joaquin River Basins
- Savannah River Basin

Future of the EFM

Grid-based period of record:

- Virtual plants – Functional criteria through time
- Mosaic of habitat
- Stronger than frequency approach
- Removal of eco-interpretation

GIS as the tool:

- Grid-based attributes to track and visualize plant communities through time
- Measures quantity and quality
- Consider habitat connectivity
- Ecosystem age structures - Habitat stability

Habitat Loss
Environmental
Prescribed Flooding
Water Quality
Conclusions…
EIS/EIR
Restoration
Eco-visualization
Aquatic and Terrestrial Habitats
Endangered Species
NEPA/CEQA
8. 23. 2001